Examination of Lines in the Solar Spectrum which are given in the Maps as common to Two or more Substances.—For this purpose a spectroscope of high dispersion has been constructed by combining the grating mentioned above, which has about 4 square inches of ruled surface, with a collimator and observing telescope each of 3 inches aperture and about 42 inches focal length, using magnifying powers ranging from 50 to 200. The apparatus is arranged upon a wooden frame-work, and when in use is strapped to the tube of the 12-feet equatorial of our observatory, so that it is kept by the driving-clock directed to the sun. An image of the sun is formed on the slit by an achromatic object-glass of 3 inches aperture, in order to increase the light and to avoid the widening of the lines due to the sun's rotation. A large prism of about 20° angle was sometimes placed in front of this object-glass (between it and the sun) to separate the colours before reaching the slit; and in examining the darker portions of the spectrum a concave cylindrical lens was sometimes used next the eye, like a shade glass, to reduce the apparent width of the spectrum and thus increase its brightness.

The grating is an admirable one, on the whole the best I have ever seen. But I have been greatly surprised at its excessive sensitiveness to distortion by pressure or inequalities of temperature. Although the plate is fully ⅜ of an inch thick, and only 3½ inches square, an abnormal pressure of less than a single ounce at one corner will materially modify its behaviour, and a quarter of a pound destroys the definition entirely. In fact the plate is not naturally exactly flat, and to get its best performance it is necessary to crowd a little wedge gently under one corner. When it is in good humour and condition, however, the performance is admirable; one could wish for nothing better, unless for a little more light in the violet portions of the spectrum.

With this instrument I have examined the 70 lines given on Ångström's map as common to two or more substances. Of the 70 lines, 56 are distinctly double or triple; 7 appear to be single; and as to the remaining 7, I am uncertain; in most cases, because I was unable to identify the lines satisfactorily on account of their falling upon spaces thickly covered with groups of fine lines, none of which are specially prominent.

As a general rule the double lines are pretty close, the distance being less than that of the components of the 1474 line. Generally also the components are unequal in width or darkness, or both, though in perhaps a quarter of the cases they are alike in appearance. The doubtful lines are the following, designated by their wave length on Angström's map: 5489·2, 5425·0, 5396·1, 5265·8, 4271·5, 4253·9 and 4226·8. I strongly suspect 5396·1 and 5265·8 (which present no difficulty in identification) of being double, but could never fairly split either of them, and therefore leave them among the doubtfuls.

Those which show no signs of doubling, so far as could be seen, were: 6121·2, 6064·5, 5019·4, 4585·3, 4578·3, 4249·8, and 4237·5.

In respect to the lines 5019·4, 4585·3 and 4237·5 it is quite possible there may be some mistake as to the coincidence, since in his *tables* Thalén gives neither of them as due to iron. An accidental strengthening of the dotted line, which, on the map, leads up from the symbol of the element concerned, through the iron spectrum, would account for the matter, by making the line appear on the map as belonging to iron also.

As the facts stand, therefore, it is obvious that arguments which have been based upon the coincidence of lines in the spectra of different elements lose much of their force; it appears likely that the coincidences are in all cases only near approximations. At the same time this is certainly not yet demonstrated. The complete investigation of the matter requires that the bright line spectra of the metals in question should be confronted with each other and with the solar spectrum under enormous dispersive power, in order that we may be able to determine which of the components of each double line belongs to one, and which to the other element. If in this research it should be found that *both* of the components of a double line were represented in the spectra of two different metals, and the suspicion of impurity were excluded, we should then indeed have a most powerful argument in favour of some identity of material or architecture in the molecules of the two substances involved.

Distortion of Solar Prominences by a Diffraction Spectroscope.—Generally, in such an instrument, the forms seen through the opened slit are either disproportionately extended, or compressed along the line of dispersion. The reason is this: if the slit be illuminated by monochromatic light, the image of the slit, formed on each side of the simple reflected image in the focus of the view-telescope (which is supposed to have the same focal length as the collimator), will have the same width as the slit itself only in one special case, not usually realised with a reflecting grating.

If the angle, between the normal to the grating and the view-telescope, is *less* than that between the normal and the collimator, the slit-image will be *narrower* than the slit, and a prominence seen through it will be *compressed* in the plane of dispersion. If the relation of the angles be reversed, then of course the distortion will also be reversed, and we shall have extension instead of compression.

The mathematical theory is very simple. Suppose the collimator and telescope to be fixed at a constant angle, as in the now usual arrangement.

Let angle between telescope and collimator $= \alpha$.
Angle between telescope and normal to grating $= \tau$.
Then angle between collimator and normal $= \kappa = \alpha - \tau$.
Also, let space between adjacent lines of grating $= s$.
And the order of spectrum observed $= n$.

Then, by principles of spectrum formation, we have

$$\lambda = \frac{s}{n} \left\{ \sin\tau - \sin\kappa \right\},$$

λ being the wave-length of the ray which is in the centre of the field of view:

whence
$$\sin\tau = \frac{n\lambda}{s} + \sin\kappa.$$

Differentiating, we have at once

$$d\tau = \frac{\cos\kappa}{\cos\tau} d\kappa, \text{ or } \frac{\cos(\alpha - \tau)}{\cos\tau} d\kappa;$$

which reduces to, $d\tau = (\cos\alpha + \sin\alpha \tan\tau)\, d\kappa$. Distortion can only disappear in cases when this coefficient of $d\kappa$ reduces to unity. Special cases—

1. If $\tau = \kappa$ there is no distortion—but also no dispersion: it is the case of simple reflection.
2. If $\kappa = 0$, the grating being kept normal to the collimator, then $d\tau = \sec\alpha\, d\kappa$.
3. If $\tau = 0$, the grating being kept normal to the telescope (which in this case must be movable), then $d\tau = \cos\alpha\, d\kappa$.
4. If $\alpha = 90°$, $d\tau = \tan\tau\, d\kappa$.
5. If $\alpha = 0$, $d\tau = d\kappa$, and there is no distortion.

This is possible only by using the same tube and object-glass both for collimator and view-telescope, the grating being slightly inclined at right angles to the plane of dispersion. The principal difficulty in this form of instrument lies in the diffuse light reflected by the surfaces of the object-glass. It is hoped that this may be nearly obviated by a special construction of the lens which will throw the reflected light outside of the eyepiece. An instrument on this plan is being made for Prof. Brackett by the Clarks, for use in the physical laboratory at Princeton, and is now nearly completed.

Princeton, September 27, 1880 C. A. YOUNG

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

DR. J. E. HARRIS (D.Sc. Lond.) has been appointed to the vacant Professorship of Natural Philosophy at Trinity College, London.

FROM the new Calendar of the University College of Wales we learn that the present number of students is fifty-seven. We see there are classes for most of the branches of science, only unfortunately they are all taught by one professor, which, to say the least, must be rather hard on him. We hope the college will soon be able to have separate teachers, at any rate for the physical and biological sciences.

THE new University Library at Halle has just been opened. It is built entirely on the French system, and special precautions have been taken with regard to fire. It now numbers some 200,000 volumes, but there is room for half a million. The cost of the building amounts to 400,000 marks (20,000*l.*).

SCIENTIFIC SERIALS

THE *American Naturalist* for December, 1880, contains:—D. Cope, on the extinct cats of America.—F. V. Hayden, Twin

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lakes and Teocalli Mountain, Central Colorado, with remarks on the glacial phenomena of that region.—C. E. Bessey, sketch of the progress of botany in the United States in the year 1879.—C. S. Minot, sketch of comparative embryology, No. 5; on the general principle of development.—The Editor's Table.—Permanent exhibition of Philadelphia.—Recent literature.—A new edition of Packard's "Zoology" is announced.—General Notes. Scientific news. Proceedings of scientific societies.

Revue des Sciences Naturelles, December, 1880, contains: Herborisations of Strobelberger about Montpellier in 1620, translated, with notes, by M. Kieffer (a complete *exposé* of the extraordinary plagiarism of Strobelberger, who copied his work on the plants of Montpellier almost *verbatim* from the work of Lobel).—M. Doumet-Adanson, on an immense Calamary taken near Cette, January, 1880 (*Ommastrephes sagittata*). This specimen was nearly six feet in length, from the end of the body to the tops of the arms.—M. S. Jourdain, on the late development of scales in the eels.—E. Dubrueil, catalogue of testaceous mollusca collected from the French shores of the Mediterranean.—M. Reitsch, an analysis of Falkenberg's researches on the fecondation and alternation of generation in Cutleria.—F. Fontannes, on the stratigraphical position of the Pliocene group of Saint Aries, in the Western Bas-Dauphiné, and particularly in the environs of Hauterives (Drôme).—Scientific Reports and Bulletin.

Gegenbaur's morphologisches Jahrbuch, Band 6, Heft 4.—Dr. M. v. Davidoff, contribution to the comparative anatomy of the posterior limb masses in fishes, 2nd part (Plates 21, 23); Dr. W. Pfitzner, on the epidermis in the amphibia (Plates 24, 25); J. E. V. Boas, on the conus arteriosus in *Butirinus albula* and in other Teleostei (Plate 26); Dr. H. Rabl-Rückhard, on the mutual relations between the chorda, hypophysis and the middle ridge of the skull in the embryos of the sharks', &c., brains (with Plates 27, 28); Carl Rabl, on the "pedicle of invagination," &c., in Planorbis (Plate 29); Prof. R. Wiedersheim, on the duplication of the os centrale in the carpus and tarsus of Axolotl (Plate 30); Prof. C. Gegenbaur, critical remarks on polydactylism as atavism; short notices; W. Leche, on the morpology of the pelvic region in the Insectivora.

Archives des Sciences Physiques et Naturelles, December 15, 1880.—Tertiary man in Portugal, by M. Choffat,—Monograph of the ancient glaciers and the erratic formation of the middle part of the Rhone valley, by MM. Falsan and Chantre.—Organic dust of the atmosphere, by Dr. Yung.—On the question of lowering of the high waters of the Lake of Constance, by M. Achard.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 6.—Observations on the Structure of the Immature Ovarian Ovum in the Bird and Rabbit, and on the Mode of Formation of the Discus Proligerus in the Rabbit and of the "Egg-Tubes" in the Dog. By E. A. Schäfer, F.R.S.

The first part of the paper is devoted to a minute description of the young ovarian ova of the bird as seen in sections of the ovary of a laying hen. The germinal spot is described as composed of two distinct substances, namely, a homogeneous matrix staining but slightly with logwood and a number of coarse granules imbedded in it, which become darkly stained. The germinal spot may often be seen to be connected with the wall of the germinal vesicle by a network of fine filaments (intranuclear network). Appearances are also described which indicate that two germinal vesicles may be originally present in one ovum (? formed by the fusion of two primitive ova), and that one of the two may afterwards disappear.

A network of filaments is also described as existing in the yolk, which in some ova shows peculiar condensations of vitelline substance, which simulate nuclei; but the origin and meaning of these are left in doubt. Other appearances, as of systems of striæ, are also mentioned as occurring in larger ovarian ova. With regard to the membranes of the ovum the author differs from Waldeyer and agrees with Balfour in regarding the *zona radiata* as a product of the protoplasm of the ovum, and not as derived from the cells of the follicular epithelium.

The ovarian ovum of the rabbit is next described, and is found to agree in most essential particulars with that of the bird. The *zona pellucida* is porous, and allows granules of food-material to pass from the epithelium cells of the Graafian follicle directly into the vitellus. But it is chiefly in this epithelium that the interest centres, for the inner layer of cells of the follicular epithelium appears to be formed in the peripheral layer of the vitellus of the ovum itself, making their appearance first of all as mere nuclei (derived in all probability from the nucleus of the ovum), around which part of the protoplasm or vitellus of the ovum becomes segmented off. This description is compared with that which Kuppfer gives of the formation of an inner layer of follicular epithelium from nuclei which make their appearance in the periphery of the vitellus of the ovum of *Ascidia canina*, and with the observations of Kleinenberg upon the formation of a layer of cells from the periphery of the ovum of *Hydra*.

Finally the gland-like nature of the ovarian tubes in the bitch's ovary is insisted upon in agreement with Pflüger and Waldeyer, and in opposition to the view taken by Foulis.

January 13.—"On the Forty-eight Co-ordinates of a Cubic Curve in Space," by William Spottiswoode, President R.S.

In a note published in the *Report* of the British Association for 1878 (Dublin), and in a fuller paper in the *Transactions* of the London Mathematical Society, 1879 (vol. x. No. 152), I have given the forms of the eighteen, or the twenty-one (as there explained), co-ordinates of a conic in space, corresponding, so far as correspondence subsists, with the six co-ordinates of a straight line in space. And in the same papers I have established the identical relations between these co-ordinates, whereby the number of independent quantities is reduced to eight, as it should be. In both cases, viz., the straight line and the cubic, the co-ordinates are to be obtained by eliminating the variables in turn from the two equations representing the line or the conic, and are, in fact, the coefficients of the equations resulting from the eliminations.

In the present paper I have followed the same procedure for the case of a cubic curve in space. Such a curve may, as is well known, be regarded as the intersection of two quadric surfaces having a generating line in common; and the result of the elimination of any one of the variables from two quadric equations satisfying this condition is of the third degree. The number of coefficients so arising is $4 \times 10 = 40$; but I have found that these forty quantities may very conveniently be replaced by forty-eight others, which are henceforward considered as the co-ordinates of the cubic curve in space.

The number of identical relations established in the present paper is thirty-four. But it will be observed that the equations are lineo-linear in each of two groups, say the U-co-ordinates and the U′-co-ordinates; and as we are concerned with the ratios only of the coefficients, and not with their absolute values, we are, in fact, concerned only with the ratios of the U-co-ordinates *inter se*, and the U′-co-ordinates *inter se*, and not with their absolute values. Hence the number of independent co-ordinates will be reduced to $48 - 34 - 2 = 12$, as it should be.

Mathematical Society, January 13.—S. Roberts, F.R.S., president, in the chair.—Miss C. A. Scott and Messrs. J. Parker Smith, O. H. Mitchell, Fellow of Johns Hopkins University, and T. Craig, U.S. Coast Survey Office, Washington, were elected members. Dr. Hirst, in drawing attention to the loss the Society had sustained by the death of M. Chasles, gave a rapid sketch of that distinguished geometer's career and work; in lightly touching upon his private life he mentioned how gratified M. Chasles had been by the fact that he was not only the first Foreign Member of the Society, but for a long time the only one. The following communications were made:—On an apparently paradoxical relation of the circle, parabola, and hyperbola, by A. J. Ellis, F.R.S.—A proof of the differential equation which is satisfied by the hypergeometric series, by the Rev. T. R. Terry.—On the periodicity of hyperelliptic integrals of the first class, by W. R. W. Roberts.—On the tangents drawn from a point to a nodal cubic, by R. A. Roberts.—Sur une propriété du paramètre de la transformée canonique des formes cubiques ternaires, by Signor Brioschi (Milan).—Note on a kinematical theorem connected with the rectilinear courses of two vessels sailing uniformly, by C. W. Merrifield, F.R.S.—A partition-problem connecting the angles of a triangle with the angles of the successive pedal triangles, by J. W. L. Glaisher, F.R.S.

PARIS

Academy of Sciences, January 10.—M. Wurtz in the chair.—The following papers were read:—On the conditions

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